Seed-Cotton Input Control for Gins

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CONTENTS

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Seed-Cotton Input Control for Gins

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Early observations by ginners and engineers showed that several aspects of ginning would be improved if controlled feeding of seed cotton to the gin by way of overhead cleaning machinery could be satisfactorily obtained. Damage to ginning machinery and lost ginning time (downtime) result from overfeeding—especially from feeding large, tight wads of seed cotton from the wagon directly into the overhead equipment. Such damage and loss have always contributed directly to increased ginning cost, and their prevention was one of the principal objectives of improved feeding control.

Another desired operational improvement was regulation of the rate of feed to maintain an even flow of cotton to all gin stands in the battery without permitting a large quantity of overflow. Uncontrolled feeding, which occurs when the wagon telescope is connected directly to the overhead machinery, results in either too little or too much cotton arriving at the gin stands. Too little cotton results in reduced ginning capacity, whereas too much results in reduced overhead cleaning efficiency plus a large overflow accumulation.

In early methods, overflow cotton was often rerouted through the overhead machinery where it was again dried and cleaned, sometimes to the detriment of fiber quality and always at greater expense to the producer. In this situation, the removal of additional weight through drying and cleaning does not increase bale value, inasmuch as this value is determined by the lowest quality cotton in the bale.

Other benefits expected of controlled and even feeding were those relating to drying and cleaning efficiency. The most practicable efficiency for a specific gin is realized when seed cotton is fed into the machinery at an even rate, just fast enough to keep all the gin stands in operation. It is desirable that the seed cotton fed be as nearly and uniformly in the single-lock state as possible, so that the maximum potential of the drying and cleaning system can be utilized.

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Early Developments

From the time Eli Whitney and Hogden Holmes developed the saw gin until after the Civil War, cotton brought to the gin was unloaded by hand and then fed into the gin stand by hand at a rate determined by the capacity and characteristics of the specific gin. In the early 1870's, a feeder was invented for even feeding of cotton into the gin, but the feeder hopper was filled by hand.

In 1884 R. S. Munger was granted a patent for an outfit that included a pneumatic system for unloading cotton wagons. The gin feeders received cotton from a belt conveyor into which the pneumatic unloader emptied. The rate of unloading was controlled manually by the ginner or left to the judgment of the suction-feeder operator. Later patents were granted on devices that improved the Munger system by regulation of the unloading by flexible check valves located above and in the gin feeders. These pneumatic elevators, first used in 1887, provided intermittent suction as required by the gin feeder; and there was no overflow, because the unloading from the wagon was regulated by the gin feeder itself.

When overhead, or bulk, seed-cotton cleaning machinery came into general use, the pneumatic chute regulator was found to be no longer practicable. For several years, the conveying and distributing of cotton to gin feeders was accomplished by conveyor belts; in more recent years, these functions have been performed by the screw conveyor. However, it was found that both conveying arrangements, located between the overhead machinery and the gin feeders, delivered cotton faster than it could be ginned. As a result, the excess cotton flowed into an overflow pen, to be picked up and ginned after the wagon was unloaded.

USDA-Designed Feed-Control Unit

In 1950, a project was set up at the U.S. Cotton Ginning Research Laboratory, Stoneville, Miss., to devise a means for regulating the rate at which seed cotton enters the ginning machinery.

During the preliminary phases of the project, the need for such a device was studied. Differences in types of cotton and harvesting methods, differences in existing seed-cotton drying and cleaning processes, and results of earlier feed-control methods were also taken into consideration. The conclusion was reached that such a device would have to control the feed of seed cotton at rates of 70 to 165 pounds per minute. It would also have to break up wads of cotton, and be so designed that it could be integrated into or added to a ginning establishment without unnecessary or complicated changes in the existing ginning machinery.

Hopper and Feed Rollers

The first step in developing the unit was to design the hopper and the feed rollers. For practical reasons, it was decided that the hopper should be of ⅓-bale capacity. This would allow time for changing trailers under the suction pipe without loss of ginning time.

Tests showed that a pair of standard extractor-feeder rollers could handle the required 70 to 165 pounds per minute. However, a ⅓-bale hopper matched to the 12-inch width required for these rollers would

call for an unreasonably deep hopper or a hopper with sloping sides. The sloping-walled hopper was found unsatisfactory because cotton bridged between the walls and failed to pass into the feed rollers.

The tests just mentioned resulted in the decision to use two sets of standard feed rollers placed side by side under a vertical-walled hopper whose dimensions were 30 by 60 inches in cross section and 8 feet deep. Directional cylinders, or picker rollers, were added under the feed rollers to break up wads of cotton passing through the unit. Tests showed that this design was practical and also that the addition of the picker rollers slightly increased the quantity of cotton delivered by the feeder rollers.

Drives and Feed Control

The first large-volume tests were made by using a V-belt drive to sheaves of different diameters. Trouble was encountered with belt slippage, especially when the hopper was nearly full. This slippage caused unevenness in feeding rate, difficulty in duplicating the feeding rates, and chokages in the feed rollers. A cam-operated, variable-speed box, designed to develop the high torque required, replaced the V-belt-and-sheave arrangement and virtually assured a constant feed-roller speed.

The unit was tested throughout the 1951 ginning season. Tabulation of feed rates (table 1) showed positive rate control, with only minor variations due to condition of cotton, speed of feed rollers, and depth of cotton in the hopper. In these tests, an overall average of 32 pounds of seed cotton was fed per revolution of the feed rollers.

Table 1.—*Rates of feed obtained with three roller velocities used on machine-picked and hand-picked cottons, crop of 1951*

Feed-roller velocity	Feed rate	Quantity of cotton fed per feed-roller revolution	
		Machine picked	Hand picked
	Pounds per minute	*Pounds*	*Pounds*
Slow	65–85	34	32
Moderate	85–110	33	32
Fast	110–155	31	28
Average		33	31

Automatic Regulation of Unloading Cotton

The early tests of the USDA-designed feed-control unit disclosed that the rate of cotton input to the hopper exceeded the feeding rate, with the result that the hopper was filled to overflowing several times during the ginning of a bale of cotton.

To prevent overflow of the hopper, an automatic cutoff for the telescope suction was devised. This consisted of a solenoid-operated cotton valve located in the line between the suction fan and the

cotton separator. This valve switched the fan suction from the unloading telescope to a capped pipe. The valve was actuated by a pressure switch located on one side of the hopper at a point approximately 2 feet from the top. This pressure switch, which was the only control element, cycled rapidly, but the relatively constant depth of the cotton permitted more even rates of feed than those achieved without the pressure switch.

Design Modification

The automatic feed-control unit now in use at the U.S. Cotton Ginning Research Laboratory, Stoneville, Miss., has undergone several changes to provide economy in construction and reliable operation. An air cylinder operated by compressed air and switching a standard cotton valve has replaced the specially constructed solenoid-operated valve. The air cylinder is actuated by an electrically controlled four-way pilot valve. This pilot valve, in turn, is actuated by two snap-action switches that control the amount of cotton fed into the hopper. These switches are so arranged and so connected that rapid cycling of the telescope suction is relieved, with consequent longer unloading and rest periods for the telescope operator.

Data obtained from laboratory tests conducted after modifications were completed are given in table 2. Three bales of each type of cotton were used for each rate of feed. The minimum rate barely permitted the three 80-saw laboratory stands to remain in operation. The fastest rate was that at which the overhead cleaners and extractors could remain in operation without choking. The medium rate was obtained by setting the rate-control lever midway between the slow and fast positions. The results of the replicated tests agreed closely, indicating that feed-rate control was easily maintained for a specific cotton.

TABLE 2.—*Results of feed-rate tests with USDA-designed seed-cotton feed-control unit, with 6 cottons fed at 3 rates, crop of 1952* [1]

Feed rate	Quantity fed per minute					
	Machine picked			Hand picked		
	Early season	Mid-season	Late season	Early season	Mid-season	Late season
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Slow	108	97	91	76	87	71
Moderate	159	148	133	161	137	105
Fast	227	196	173	294	221	151

[1] Average of 3 replications for each test condition.

These data also show typical rate requirements for different cotton conditions as affected by method and period of harvesting. Although the fast feed rates tabulated were determined by the capacity of the overhead machinery, they do not represent maximum feed rates of

the unit. Inasmuch as the slowest rate used was sufficient to maintain these 80-saw stands, it can be seen that the fastest rates in all instances but one would feed six 80-saw stands or five 90-saw stands.

The feed rate that barely permits all gin stands to remain in operation is the rate recommended for normal feeding operations.

Commercial Models

Shortly after the first USDA-designed model was constructed at the Stoneville laboratory and its benefits had been demonstrated, commercial gin manufacturers proceeded to design and produce feed-control units of their own to meet the need of ginners for such a device. The commercial models vary in design and in installation details, but they all represent progress in the attainment of smoother and more satisfactory ginning operation.

Construction and Installation of USDA-Designed Automatic Feed-Control Unit

To enable the ginner to build a feed-control unit patterned after the USDA-designed model, the drawings and photographs in figures 1 through 7 provide sufficient detail as to items required and general arrangement. All parts are standard and are readily available. Very few of the items have been dimensioned because parts used may differ in one or more dimensions.

It is anticipated that major elements of the feed control are likely to be constructed from parts taken from used or idle machinery. A logical beginning would be to assemble the two sets of feed rollers with their associated breaker or directional cylinders. (See figs. 3 and 4.) An old extractor-feeder would supply one pair of feed rollers and one directional cylinder that could be used without modification. When these items are reassembled for use in a feed-control unit, the directional cylinder should be mounted beneath its feed rollers in about the same relation as when it is used in the extractor-feeder.

The adapter is approximately 24 inches high from feed section to vacuum dropper, as measured from the feed-roller support frame, and is constructed to connect to the particular vacuum dropper used.

When the feed section of the unit is completed, it should be installed in the gin, where the hopper and vacuum dropper are fitted to it. The hopper itself may be constructed as a single box or in sections to be fastened together. The recommended location of the unit is directly below the unloading separator. Cotton may be conveyed from the feed-control unit to the first stage of drying through the hot-air line to the drier.

Details of the attachment of the air cylinder to the cotton valves are shown in figure 5. Three such units are required to control the unloading rate, to switch from unloading line to overflow pickup, and at the same time to route the overflow cotton directly to the conveyor-distributor as illustrated in figure 6.

The necessary electrical connections are shown schematically in figure 7. To simplify the drawing, connections between points marked "X" have been omitted. For the electrical connections to be complete,

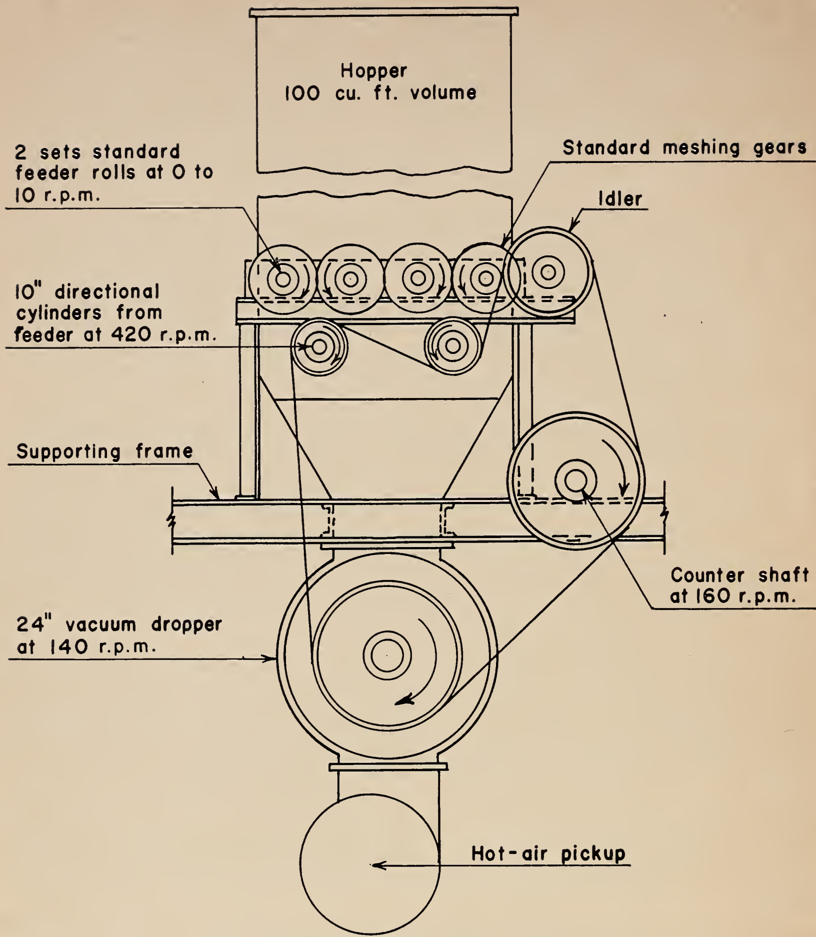

Figure 1.—Construction details of USDA-designed automatic feed-control unit (left-hand elevation).

it is necessary that *all* points marked "X" be connected. All wiring should conform to local wiring codes.

Identification and general description of the electrical items follows:

The nominal 115-volt power input is fused with a 3-ampere fuse and brought to a single-pole, single-throw toggle switch. The indicator lights are not necessary to the operation of the unit, but are suggested because they add considerably to the appearance of the panel and provide the gin operator with a visual indication of switch settings. A single-pole, double-throw toggle switch is used to put suction on either the unloading telescope or the overflow pickup line.

Switches marked "S–1" and "S–2" are low-pressure, snap-action, normally open switches mounted on the hopper wall to control the unloading valve V–1. Location of these switches with respect to top and bottom of the hopper are such that the hopper will not overflow

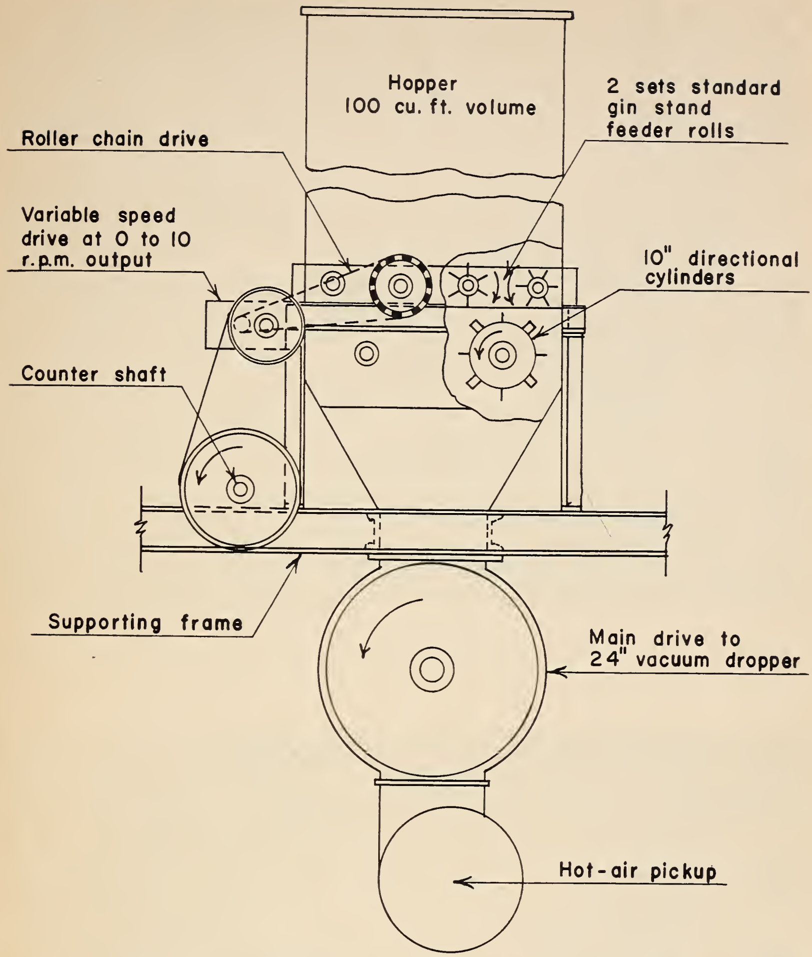

FIGURE 2.—Construction details of USDA-designed automatic feed-control unit (right-hand elevation).

before unloading is stopped and will not empty itself completely before unloading is resumed. The specific location of these switches depends on the measurements and capacity of the hopper. The double-pole, single-throw (DPST), normally open relay has a 115-volt, alternating-current-type coil and heavy-duty, silvered-contact switch points. A double-pole, single-throw relay may be simply provided from a double-pole, double-throw relay by not using the normally closed pair of contacts.

Coils marked "V–1," "V–2," and "V–3" represent the solenoid sections of the four-way pilot valves located at each of the cotton valves V–1, V–2, and V–3.

A qualified radio mechanic or electrician should be able to construct a very satisfactory control panel.

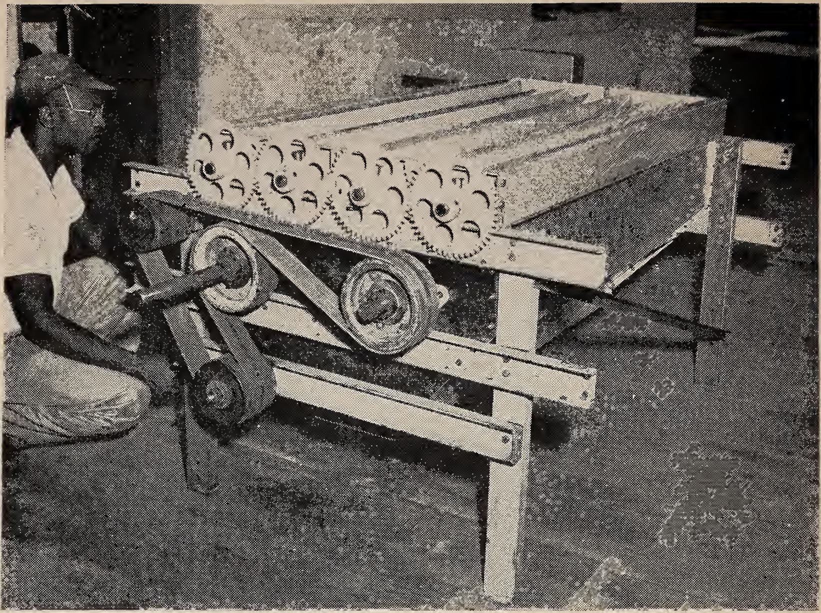

FIGURE 3.—First step in construction of USDA-designed feed-control unit. Two pairs of feed rollers are mounted together, with their associated breaker rollers mounted as originally used in gin-stand feeder. Extended shaft receives driving pulley.

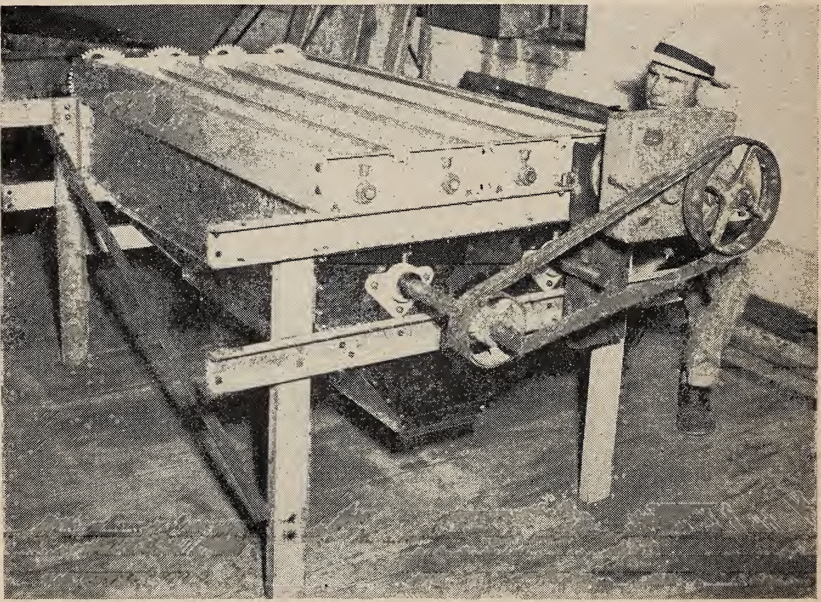

FIGURE 4.—Second step in construction of USDA-designed feed-control unit. Hopper transition below feed rollers has been shaped to fit vacuum-dropper inlet. Height of transition is approximately 24 inches.

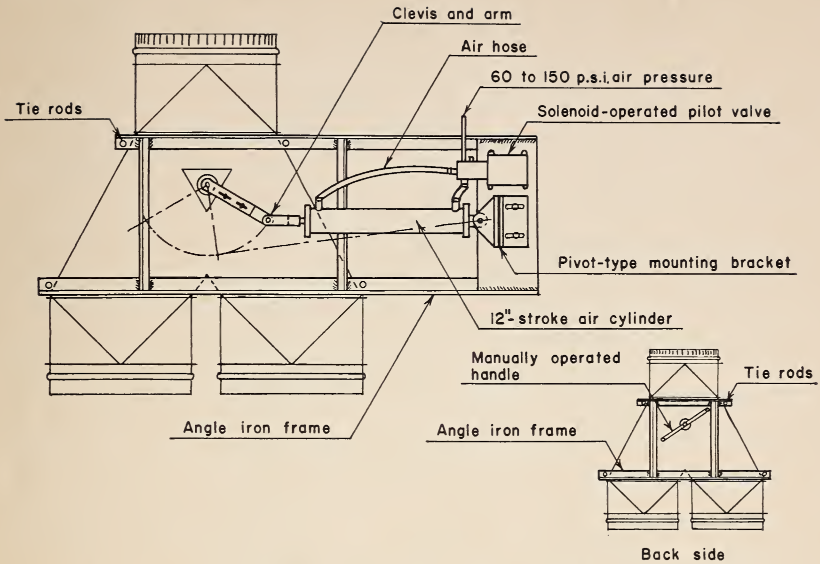

FIGURE 5.—Construction details of standard cotton valve with air cylinder and handle for chain operation.

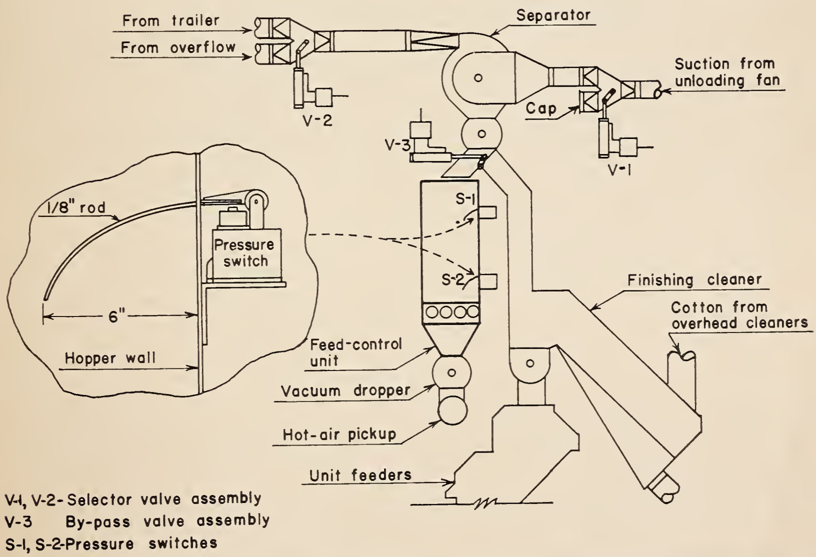

FIGURE 6.—Integration of USDA-designed automatic feed-control unit into gin processes, and installation details of pressure switches.

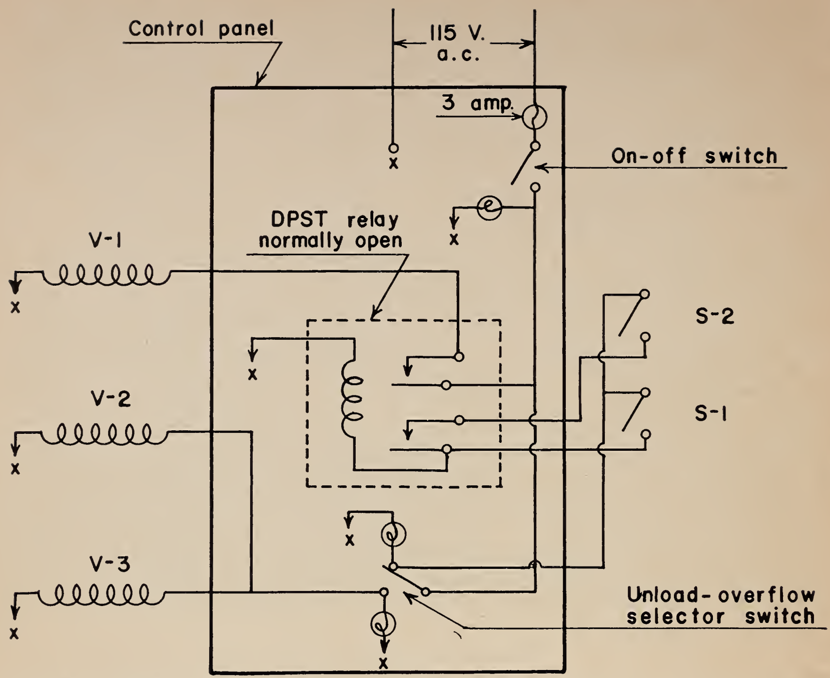

FIGURE 7.—Electric circuits uniting source, control switches, and cotton valves.

Operation of Completed System

After they have been fabricated and installed, the major components must be connected to both electric and compressed-air sources. When the control-panel switch is in the ON position, operation of valves V–2 and V–3 may be checked by manipulating the selector switch on the control panel. Valve V–1 may be checked by simultaneously depressing both S–1 and S–2 in the hopper. It is recommended that the gin machinery not be running during these tests.

In normal gin operation before the cotton is in the system, the selector switch is in the UNLOAD position; and because the two hopper switches are open, suction should be applied to the unloading telescope. As cotton falls into the hopper, the feed rollers pass it on to the vacuum dropper, which drops it into the hot-air line leading to the first drier. The rate of feeding required to keep all gin stands in operation is easily regulated manually by the gin operator with the aid of an extended handle on the variable-speed drive. As the driving speed varies with different gins and different cottons, no specific rates are recommended in this publication.

When cotton begins to fill the hopper, switch S–2 closes because of the weight of cotton above it. Unloading continues until switch S–1 near the top of the hopper closes. Switches S–1 and S–2 then are both closed; and valve V–1, actuated by the relay, removes suction from the unloading telescope so that unloading ceases temporarily. *It should be emphasized that the leg of cotton valve V–1 in use at this time must*

be capped to prevent overloading the unloading fan. An additional reason for capping this valve leg is to prevent air leakage when the valve is in UNLOADING position.

Now that no cotton is entering the hopper, the feeding action continues, and the level of cotton in the hopper drops. Switch S–1 opens, but unloading cannot be resumed until the level falls to the point where switch S–2 also opens.

At this time, both hopper switches are open. A spring in the solenoid at valve V–1 causes the pilot valve to reverse the direction of air into the cylinder. Valve V–1 is returned to its original position, and unloading again begins. This cycle is repeated until the cotton trailer is emptied or until the gin operator cuts off the current.

When the trailer has been emptied, the gin yardman pulls another trailer under the unloading telescope. As the last of the cotton is fed from the hopper, the ginner throws the selector switch to OVERFLOW position and picks up the overflow cotton, which is automatically routed directly to the conveyor-distributor. When this overflow cotton has been picked up, the ginner throws the selector switch to the UNLOAD position, and the hopper again begins to fill with cotton from the new load.

If it becomes necessary during the ginning process to pick up the overflow cotton while there is cotton in the hopper, it is important to remember that unless feeding from the hopper is halted by stopping the variable-speed feed drive, cotton from both overflow and overhead gin machinery will enter the conveyor-distributor simultaneously. In the majority of gins, the conveyor-distributor has ample capacity to accommodate two inputs. Under normal operating conditions, the quantity of cotton from the overflow should be so slight that no real difficulty exists. This problem is easily solved by the ginner becoming acquainted with the automatic feed control and its operation.

Summary

An efficient method of controlling the rate of seed-cotton flow into gin machinery is highly desirable, primarily for the prevention of troublesome and sometimes expensive choking of machinery caused by fast feeding rates, and secondarily because even feeding permits more uniform drying and cleaning during ginning. The USDA-designed seed-cotton feed-control unit, as well as various commercial models, has proved equal to the need.

The construction information provided in this publication has been used to build seed-cotton feed-control units by utilizing basic parts from several sources, that is, from different gin-machinery manufacturers. All units so devised have operated satisfactorily.

Large-scale tests have shown that feeding rates vary widely, depending on the number of gin stands to be fed as well as on the moisture content and foreign-matter content of the cotton. The recommended feeding rate, which is easily controlled by the ginner, is that rate that barely permits all the gin stands to remain in operation.

The automatically switched bypass valves return the overflow directly to the conveyor-distributor and thereby prevent the occurrence of two-sided bales. A two-sided bale is one that contains lint of one

grade or staple length on one side and lint of a different grade or staple length on the other side.

Additional construction and operational information may be obtained by writing direct to the U.S. Cotton Ginning Research Laboratory, Box 426, Leland, Miss.

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